

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
Second Semester 2021-2022
CHE F244: Separation Processes-I
Mid-Semester Examination

Date: 10.03.2022

Time: 2:00-3:30 PM

Maximum Marks: 90

Note: The question paper consists of two parts. Answer **Part A** and **Part B** in separate answer books. Collect answer book for **Part B** after submitting **Part A** answer book.

PART – A (Closed Book)

Time: 2:00 - 2.30 P.M.

Marks: 20

1. (2 Marks) What are the two agents that can be used to create a second phase in the separation of a chemical mixture? Which is the most common?
2. (2 Marks) How does the mechanism of separation for a microporous membrane differ from that of a nonporous membrane?
3. (2 Marks) What are the five general separation techniques and what do they all have in common?
4. (3 Marks) Give examples for separation through effusion, liquid permeation, dialysis and reverse osmosis
5. (2 Marks) Why is mass transfer a major factor in separation processes? What limits the extent to which the separation of a mixture can be achieved?
6. (2 Marks) List at least five property differences that can be exploited to develop a separation process.
7. (2 Marks) What is osmosis? Why can't it be used to separate a liquid mixture?
8. (2 Marks) How do reverse osmosis and dialysis differ? What do they have in common?
9. (3 Marks) Define split fraction (SF), split ratio (SR) and separation power (SP).

~

PART – B (Open Book)

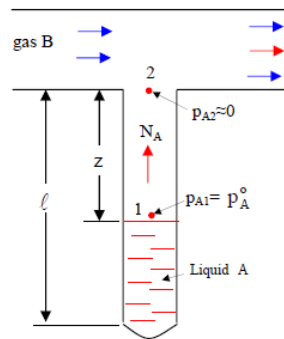
Time: 2:30 – 3:30 P.M.

Marks: 70

Note: Only Text book, class notes and photocopy of slides are allowed.

1. **(15 Marks)**. Obtain the mass transfer coefficient k_L in m/s for evaporation of water into air in a 2-in.-diameter wetted-wall column at a Reynolds number of 10,000 and temperature 40°C if the effective thickness of gas film is 0.16 cm. Given: viscosity of air = 0.0186 cP and diffusivity for this air-water system = 0.2814 cm²/s.

2. **(25 Marks)** Unimolar diffusion can be used to estimate the binary diffusivity of a binary gas pair as shown in the figure below. Consider the evaporation of CCl₄ (A) into a tube containing O₂ (B). The distance between the CCl₄ level and the top of the tube is 16.5 cm. The total pressure in the system is 760 mm Hg and the temperature -5°C. The vapor pressure of CCl₄ at that temperature is 29.5 mm Hg. The area of diffusion path in the diffusion tube may be taken as 0.80 cm². Determine the binary diffusivity, D_{AB} , in cm²/s, when in an 11-hour period after steady state 0.026 cm³ of CCl₄ is evaporated.



3. **(30 Marks)** A 150 kmol/h gas consisting of ammonia (A) and air (C) will be washed with water (S) in a plate column operating at 20°C and 800 mmHg. Gas contains 20 percent ammonia by volume and this will be reduced to 1.96 percent. The water, which is ammonia-free, will be supplied at a flow rate of 2581 kg/h. Calculate:
 - a) The concentration of liquid solution leaving the column,
 - b) The percentage recovery of ammonia,
 - c) The number of the equilibrium plates needed,

The equilibrium data (in ‘mole solute/mole non-solute’) is given below:

X (in liq. phase)	0.212	0.159	0.106	0.079	0.053	0.042	0.032	0.021
Y (in gas phase)	0.262	0.167	0.095	0.067	0.042	0.032	0.024	0.015